

WO 2005/065843

PATENT APPLICATION

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Steven P. Marsh, Esq.

(Name)



Signature

High frequency spraying device

250 PARK AVENUE

NEW YORK, NEW YORK 10177

TO ALL WHOM IT MAY CONCERN:

Be it known that we, JÜRGEN KUNSTMANN, JÖRG RATHENOW, and SOHÉIL ASGARI, all citizens of Germany, residing at Kronthaler Strasse 38, 65812 Bad Soden, Germany, Rheingaustrasse 119, 65203 Wiesbaden, Germany, and Sonnenbergerstrasse 5, 65193 Wiesbaden, Germany, respectively, have invented certain new and useful improvements in

HIGH-FREQUENCY SPRAYING DEVICE

of which the following is a specification.

WO 2005/065843

PATENT APPLICATION

CROSS REFERENCE TO RELATED APPLICATION(S)

[0001] This application is a national stage application of PCT Application No. PCT/EP2005/000041 which was filed on January 5, 2005, and published on July 21, 2005 as International Publication No. WO/2005/065843 (the "International Application"), the entire disclosure of which is incorporated herein by reference. This application claims priority from the International Application pursuant to 35 U.S.C. § 365. The present application also claims priority under 35 U.S.C. § 119 from German Patent Application DE 10 2004 001 095.1, filed on January 5, 2004, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates generally to a high frequency spraying device suitable for atomising a coating fluid, which device is equipped with a drying device for drying and/or cross-linking the coating fluid applied to the body to be coated by means of the high frequency spraying device, wherein the device also has
The present invention relates to a high-frequency spraying apparatus that can be capable of atomizing a coating fluid, and which may be equipped with a drying assembly that can be configured to dry and/or cross-link the coating fluid after it is applied to a body to be coated. The spraying apparatus may also include a substrate support which is suitable for
can be capable of retaining the body to be coated firmly in a position suitable for coating during the coating process. In particular, this invention relates to such a high frequency atomising device which does not atomise the coating fluid by means of a pressure loaded nozzle but which

WO 2005/065843

PATENT APPLICATION

~~atomises the coating fluid without force and without air induction by means of~~ For example, the present invention also relates to a high-frequency atomizing apparatus which can atomize the coating fluid using a resonance body that can be excited to produce high frequency vibrations, forming a spray mist. According to the invention such devices are also included in which a movement of the substrate and/or the atomising device takes place for the coating process, and thereby form a spray mist.

BACKGROUND INFORMATION

[0003] ~~The high~~ High-frequency vibrations produced by the excitation of the resonance body may, for example, a resonance body can be generated in an electromechanical converter by means of using piezoceramic elements which have been excited to produce electrical mechanical vibrations. These mechanical vibrations produced by means of the piezoceramic elements may then may, when amplified, be fed provided to the resonance body. With these mechanical high frequency vibrations a A coating fluid film applied continuously to the resonance body can be excited by these mechanical high-frequency vibrations to form capillary waves ~~so that fine.~~ Fine droplets on the vibration cavities ~~forming~~ which may form on the capillary wave ~~are~~ can be cut off, ~~as~~ which can result in the formation of which an atomisation atomization or spray mist ~~is formed.~~

[0004] ~~Possible applications for such a pressure less~~ Applications for a pressureless high frequency atomising atomizing device may be found include, for

WO 2005/065843

PATENT APPLICATION

example, ~~in the fields of~~ air or product moistening, microelectronics, medical engineering, etc. Further, ~~such pressure less~~pressureless high ~~frequency~~ ~~atomising~~atomizing devices may ~~prove very~~be suitable for ~~the~~ gassing and/or degassing of fluids. ~~Similarly, the high~~ High-frequency ~~atomising~~atomizing devices ~~mentioned may also~~ be suitable for ~~the~~ use as separating ~~means~~devices and/or for the delivery of fluids in filling and mixing processes.

[0005] ~~However, particular importance is attached to these~~ ~~high~~ High-frequency ~~atomising~~atomizing devices may also be used in the field of medical engineering, for example, for coating of mechanical implants, ~~for example~~ bone and joint screws, heart valve prostheses and filigree substrates, ~~particularly~~ vascular supports, ~~such as stents for instance, thinly and homogeneously with a~~ coating fluid. For instance, closed coat thicknesses of approx. 1 nm to approx. 1 mm, if necessary even more, can be achieved with the device according to the invention. Preferred coat thicknesses range from 1 nm to 100 μ m, and in particular preference from 1 nm to 10 μ m, e.g. 1 nm to 1 μ m or 10 nm to 1 μ m, and in particular preference from 1 nm to 10 nm. Such stents are such as stents, etc., with a thin and homogeneous layer of a coating fluid. These stents may be required, for example, to permanently protect ~~the~~a coronary artery of a cardiac infarction patient, which was widened by means of a balloon dilation, ~~permanently~~ from renewed occlusion. ~~In order to~~ To protect the coronary artery ~~permanently~~ from renewed occlusion, ~~such stents, which,~~ a stent which can assume, for example, the shape of

WO 2005/065843

PATENT APPLICATION

a hollow cylindrical wire netting in the ~~nature~~form of a lattice gate, comparable to a hair curler, ~~are~~can be fitted into the coronary vessel. In this manner, ~~thus preventing~~ renewed occlusion of the vessel can be prevented or ~~allowing~~ at least ~~its~~ temporary postponement thereof may be allowed in many cases.

[0006] ~~To ensure that these~~These stents, ~~like~~together with other medical implants or other bodies to be coated, ~~which are~~can be referred to collectively ~~in the following as substrates, are.~~ To ensure that the substrate is not rejected by ~~the~~a human organism, ~~it is necessary to provide these substrates~~such substrate may be provided with a suitable coating ~~which~~that is not rejected by the human or animal body. To coat these substrates, which ~~are often very~~can be fine and/or filigree in nature, ~~the~~a high ~~frequency atomising~~atomizing device ~~previously mentioned may be used in preference, for example.~~

[0007] An ~~atomising~~atomizing device which ~~is~~may be suitable for ~~atomising~~atomizing a coating fluid, ~~without using force or air induction is described, is disclosed, for example, in US patent no~~U.S. Patent No. 4,655,393. The ultrasonic atomiser disclosed in this patent consists essentially of described therein includes two tubes connected to each other by ~~means of~~ a flanged connection oriented in thea longitudinal direction, ~~wherein a.~~ A drive element is inserted between the ~~two~~ adjacent flanges of both tubes, ~~in order to~~which can excite the ~~atomising unit~~an atomizing arrangement to generate ~~vibrations in the ultrasonic range.~~vibrations. A feed hose is connected to ~~the~~a back portion of the ultrasonic ~~atomiser~~

WO 2005/065843

PATENT APPLICATION

~~for~~ atomizing arrangement that is capable of feeding the ~~atomising device~~ with coating fluid. ~~On the front of the atomiser all the~~ to the atomizing arrangement. The tubes on the front ~~is~~ of the atomizing arrangement are reduced in ~~its~~ diameter ~~to enable~~ diameter to allow a further solid tube section ~~with~~ having a smaller diameter to be formed. ~~This~~ The cross-section of this further tube section widens ~~in its~~ cross section, ~~in the direction of the front of the~~ towards the front of the atomizing device, viewed along a circular trajectory, and terminates in a flat ~~atomiser~~ atomizer tip.

[0008] The flat ~~atomiser~~ atomizer tip and the inner cavity of the front tubes of the ~~atomising~~ atomizing device described in U.S. Patent No. 4,655,393 are connected by a plurality of thin rectilinear capillary tubes ~~in order~~ configured to load the ~~atomiser~~ atomizer tip with a coating ~~means~~ fluid that ~~is~~ may be excited to generate high ~~is~~ frequency vibrations. However, these fine tubes terminate obtusely and ~~without any~~ continuous process ~~discontinuously~~ in the flat tip of the ~~atomising~~ atomizing device. Nevertheless, ~~the continuous~~ This discontinuous transition between the tubes and the flat tip ~~results~~ can result in an irregular spray pattern during ~~the~~ operation of ~~this~~ the atomizing device, and ~~in particular~~ in an irregular droplet size in the spray mist produced. ~~In particular~~ For example, drops of larger diameter ~~are~~ may also be formed as a ~~result~~ because of this discontinuous transition, ~~which~~ where the larger drops may accumulate initially on the tip of the ~~atomising~~ a tip of the atomizing device and ~~become detached~~ then detach from the ~~atomiser~~ tip due to the

WO 2005/065843

PATENT APPLICATION

~~action of the force of~~atomizer tip in response to gravity forces when they reach a certain size. ~~This is one~~ For at least this reason, among others, ~~why the atomising~~atomizing device disclosed~~described~~ in ~~US~~U.S. Patent No. 4,655,393 ~~should only be~~may prevent formation of larger drops when used in a vertical alignment with an upward pointing spray tip or in a horizontal alignment. However, ~~where the~~if a substrate to be coated is ~~to be arranged underneath~~provided beneath this ~~atomising~~atomizing device, or even in the case ~~of if~~ very thin, uniform coatings are being applied, ~~it is frequently the case that~~ larger drops may become detached from the spray tip and drip onto the substrate, ~~thereby rendering~~which may render it useless for further application ~~or impair its performance.~~

[0009] Another problem which may be associated with the coating of substrates ~~consists in the fact that~~relates to a substrate holder which can retain such substrates are normally while being coated initially in a first stage ~~in which they are retained by a first substrate holder so that they can be coated by means of a spraying device. However, the substrate must then normally be removed from this first substrate holder~~using a spraying device. It may be necessary to remove the substrate from this substrate holder so that it can then be inserted ~~in, for example, into~~ a drying oven for drying and/or hardening, ~~for example. But this removal.~~ Removal of the substrate from the substrate holder ~~proves~~can be problematic because when the substrate is removed from the first substrate holder ~~the~~if freshly applied, not yet set coating film

WO 2005/065843

PATENT APPLICATION

~~can easily be damaged, as a result of which the substrate would also be rendered~~be damaged easily, as such damage may occur upon removing the substrate from the holder which can render the substrate unusable for further an intended
application.

[0010] A further problem ~~that may be~~ encountered when coating substrates with ~~using a~~
~~conventional~~ high frequency ~~atomising~~atomizing device such as that ~~disclosed in~~
~~US~~described, e.g., in U.S. Patent No. 4,655,393, for example, consists inrelates to
the ~~fact~~observation that the spray mist produced by such an ~~atomising~~atomizing device
~~can~~may only be capable of being modulated by the coating fluid supplied per unit of time ~~of~~
~~the atomising device and by~~at the excitation frequency. ~~However, it is~~ It
may not be possible to influence the spraying characteristic further, e.g. ~~for widening or~~
~~narrowing, to widen or narrow~~ the spray jet or ~~for accelerating~~to accelerate the spray
mist by ~~giving it a certain~~guiding it in a particular direction.

[0011] ~~In the light of the problems described above, which may be encountered when coating a substrate with a high frequency atomising device, for example, the object of this invention is therefore to make available an improved high frequency atomising device for~~Thus, there may be a need to provide an improved
high-frequency atomizing device capable of coating filigree substrates, which device generally
does not suffer from the disadvantage of the formation of larger drops, ~~so that it~~and which
~~can also be operated with a downwardly~~downward-directed resonance body.

WO 2005/065843

PATENT APPLICATION

~~Furthermore, the aforementioned problem caused when the~~ Further, there
may be a need to provide an improved high-frequency atomizing device that can provide
coatings that are not likely to be damaged when coated substrates are removed from the substrate
holder, ~~in order to be able~~ for example, to insert them in a drying oven for hardening,
~~for example, will also be solved with this invention. Moreover,~~
~~a high frequency atomising device will be supplied which enables~~
~~the spray jet to be influenced not only by setting the.~~ There may
also be a need to provide, for example, a high-frequency atomizing device that can influence the
spray jet characteristics, not only by varying a coating fluid flow rate and ~~the atomiser an~~
~~atomizer~~ frequency, but also enables the spray jet to be accelerated ~~or by~~
accelerating the spray jet and/ or allowing the spray cone to be widened or ~~reduced.~~ narrowed.

OBJECTS AND SUMMARY OF EXEMPLARY EMBODIMENTS OF THE INVENTION

[0012] It is one of the objects of the present invention to provide a high-frequency
atomizing device capable of coating a substrate, which includes an atomizing arrangement that
can be excited to produce high-frequency vibrations, and which can atomize the coating fluid fed
to it to form a spray mist. The exemplary atomizing arrangement can include a resonance body
having a trumpet-like shape. The atomizing arrangement can be enclosed in a housing having an
opening, and the resonance body can be positioned proximate to the opening. The housing may
further be provided with a flow of air or inert gas from a gas supply. The housing can also
include a nozzle associated with the opening through which the supplied flow of air or gas may
escape.

WO 2005/065843

PATENT APPLICATION

[0013] ~~According to a first aspect of this invention, these objects are achieved and problems solved for the first time with a high frequency atomising device for atomising a coating fluid and coating a substrate which has an atomising unit which can be excited to produce high frequency vibrations, which unit atomises the coating fluid fed to it to form a spray mist, and which is also equipped~~The atomizing device may also be provided with a positionable substrate holder which ~~retains~~is capable of retaining the substrate to be coated in a position ~~favourable~~favorable for coating inside the spray mist produced by the high frequency ~~atomising~~atomizing device throughout the ~~atomising~~atomizing and coating process, ~~thus enabling~~which may allow the substrate to be wetted uniformly with the spray mist produced, and further allow thin, homogeneous coats to be applied.

[0014] According to an ~~alternative~~one exemplary embodiment of the present invention, the entire ~~atomising unit~~atomizing arrangement can also be moved along a substrate, or alternatively, a movably arranged substrate can be provided with a movably arranged ~~atomising unit~~exemplary atomizing arrangement.

[0015] ~~In order to counteract the problem already described, which occurs when the freshly coated substrates are removed, the high frequency atomising~~According to another exemplary embodiment of the present invention, the high-frequency atomizing device may also include a heat source which ~~is~~can be suitable for drying the spray mist coat formed on the substrate without ~~having to~~

WO 2005/065843

PATENT APPLICATION

~~removing~~requiring removal of the substrate from the substrate holder. ~~This therefore affords the advantage, which can be achieved with this invention, that the freshly coated substrate need not be removed~~
Thus, it would not be necessary to remove a freshly-coated substrate from the substrate holder for drying, thereby ~~obviating the risk~~reducing the likelihood of damaging the freshly ~~coating-coated~~coated substrate or the ~~freshly~~freshly ~~applied~~applied coating film.

[0016] According to a further exemplary embodiment of the present invention, the high-frequency atomizing device may also include one or more temperature setting arrangements, which can be provided to heat or cool certain elements or areas associated with the atomizing device. Certain elements that can be heated or cooled by these arrangements can include, e.g., a tank that may be used to hold the coating fluid, tubes or pipes that can transport the coating fluid between various components of the atomizing device, a pump that may be used to pump the coating fluid, and/or supply tubes that convey air or inert gas.

[0017] These and other objects, features and advantages of the present invention will become apparent upon reading the following detailed description of embodiments of the invention, when taken in conjunction with the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Further objects, features and advantages of the invention will become apparent from the following detailed description taken in conjunction with the accompanying figures showing illustrative embodiments of the invention, in which:

WO 2005/065843

PATENT APPLICATION

[0019] Fig. 1 is a schematic illustration of a high-frequency atomizing device in accordance with certain exemplary embodiments of the present invention;

[0020] Fig. 2 is a cross-section illustration through a resonance body of the atomizing device in accordance with certain exemplary embodiments of the present invention; and

[0021] Fig. 3 is a schematic illustration of the high-frequency atomizing device according to another exemplary embodiment of the present invention which includes temperature setting arrangements and arrangements capable of generating electrical and/or magnetic fields.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS OF INVENTION

[0022] In the figures, similar elements are identified with corresponding reference symbols.

[0023] ~~As already explained, the atomising unit incorporates an ultrasonic atomiser which is suitable for atomising a coating fluid fed to the atomising unit into a fine spray mist. To produce the~~ According to an exemplary embodiment of the present invention, an atomizing arrangement can be provided which includes an ultrasonic atomizer that may be suitable for atomizing a coating fluid fed to the atomizing arrangement into a fine spray mist. The exemplary ultrasonic atomizer can produce high -frequency ultrasonic waves, the ultrasonic atomiser is provided that may include, for example, with a piezoceramic element which ~~converts~~ can convert electric weaves to signals into mechanical waves, whereby a coating fluid fed. Thus a coating fluid provided

WO 2005/065843

PATENT APPLICATION

~~without pressure to the ultrasonic atomiser forms capillary waves from whose vibration cavities very fine droplets are detached. In order to feed the coating fluid as uniformly and continuously as possible to the atomiser tip of the atomising unit, from which the coating fluid excited to generate vibrations is sprayed down, the atomising unit is~~atomizer can form capillary waves, and fine droplets may be detached from vibration cavities associated with these capillary waves. The exemplary atomizing arrangement can be provided with a resonance body which widens into ~~the shape of a trumpet. This capillary type resonance body widening into the shape of a trumpet vibrates~~a trumpet-like shape that is capable of feeding the coating fluid uniformly and continuously to the atomizer tip of the atomizing arrangement, from which the coating fluid is sprayed. This capillary-type resonance body that widens into a trumpet-like shape can vibrate together with the ultrasonic ~~atomiser~~atomizer at an excited frequency. In this manner, the coating fluid fed to the resonance body can also vibrate in the excited frequency, so that the coating fluid fed to the resonance body also vibrates in the excited frequency on over the surface of the resonance body and forms the capillary waves already mentionedfrom the capillary waves described herein above.

[0024] ~~In order to supply the resonance body that widens into the shape of a trumpet~~To supply the resonance body uniformly and continuously with coating fluid, the resonance body ~~widening into the shape of a trumpet is~~can be connected to a capillary tube by ~~which the inner face of the resonance~~

WO 2005/065843

PATENT APPLICATION

~~body is supplied with coating fluid. that is configured to provide the inner face of the resonance body with coating fluid. To ensure that there are no discontinuities from the that may allow escape of the coating fluid from the capillary tube and during the transition to the inner face of the resonance body, the capillary tube is~~ as it is provided to the inner face of the resonance body, the capillary tube can be incorporated in a nozzle of the resonance body ~~widening into the shape of a trumpet so that the end of the capillary tube passes into the resonance body without any jumps or steps. When the coating fluid~~ The coating fluid that escapes from the capillary tube ~~it is~~ may therefore be distributed on ~~the an~~ an inner face of the resonance body in a thin film, ~~which inner face widens~~ where the inner face may widen concentrically ~~into the shape of~~ to form a trumpet-like shape.

[0025] According to a ~~preferred~~ further exemplary embodiment of the present invention, the resonance body ~~that widens into the shape of a trumpet may be designed~~ provided in the shape of a horn ~~which that~~ widens, for example, as viewed in cross-section, ~~to perform~~ for example, in a form of a tractrix function, an exponential function or a clotoid function, ~~to mention but a few. or other similar forms.~~ To increase the ~~atomising~~ atomizing area of the resonance body, a funnel-shaped section, for example, can be connected to the horn of the resonance body described above. ~~It is also possible to widen the horn of the resonance body~~ herein above. The horn of the resonance body may also be widened to such an extent that the radius of curvature of the horn is parallel ~~with~~ to the capillary tube incorporated in the resonance body. In this case exemplary

~~WO 2005/065843~~PATENT APPLICATION

~~configuration, the horn could be continued outwards~~can be extended outward at its outer opening in a perforated disc whose single hole then coincides with the horn opening. One advantage that can be achieved by such an enlargement of the resonance body may consist in the fact that, for example, as a perforated disc including a single hole that may coincide with the horn opening. This enlargement of the resonance body can permit the entire quantity of coating fluid fed to the resonance body via the capillary tube ~~is atomised. Due to be~~ atomized. This enlargement of the enlargement of the resonance body it can therefore be ensured that no non-atomised can further prevent non-atomized residues of the coating fluid ~~accumulate~~from accumulating on the resonance body that would, where such residues can otherwise drop down without being atomised onto ~~one~~an edge of the resonance body ~~due~~in response to gravity without being atomized.

[0026] Furthermore, ~~to~~To avoid the detachment of large coating fluid ~~drips~~drops on the resonance body, ~~or differences~~and/or to prevent variations in the coat thickness of the coating fluid film formed on the inner face of the horn, the resonance body which, ~~as stated previously,~~ passes into a circular perforated disc, ~~is ideally~~as described above, can be loaded with coating fluid by means of using, e.g., a controllable, pulsation-free proportioning pump. ~~Although proportioning~~ Proportioning quantities ~~of~~between about 0.1 to 100 ml/min, and preferably 0.5 ml/min., ~~prove advantageous for the use of the high frequency atomising device mentioned previously~~or about 0.5 ml/min., can be used with, e.g., the conventional high-

WO 2005/065843

PATENT APPLICATION

~~frequency atomizing device described above~~ in connection with ~~the~~ medical engineering field, ~~the~~ applications. ~~The exemplary high frequency atomising device can of course~~ atomizing device in accordance with exemplary embodiments of the present invention may be operated with other proportioning quantities ~~where~~ including, e.g., volumetric flows of up to about 50 l per hour can be achieved without difficulty, or where smaller volumetric flows ~~of~~ on the order of about 1 µl/min., ~~for example,~~ can be achieved.

[0027] ~~To obtain the best possible spray pattern without detachment of undesirable drops~~ In accordance with the exemplary embodiments of the present invention, the individual dimensions of the device ~~according to the invention are~~ can be matched to each other, ~~also~~ taking into consideration the volumetric flow of the coating means and its viscosity. ~~For the usual~~ and viscosity of the coating fluid, to obtain an improved spray pattern while avoiding detachment of undesirable drops. For conventional applications in the medical field ~~it has normally proved appropriate to select,~~ the inside diameter of the capillary tube ~~ranging from~~ can be selected to be between about 0.01 to and 15 mm. ~~For the~~ For conventional coating fluids suitable for coating medical substrates, the diameter of the capillary tube ~~should preferably~~ can be chosen within the range ~~of~~ to be between about 0.3. mm to and 0.5 mm, but ~~preferably~~ or approximately 0.4 mm. The diameter of the expanding resonance body ~~must~~ can be matched ~~correspondingly to this tube,~~ and here ~~diameters~~ a diameter of between about 3 and 30 mm have proved suitable can be

WO 2005/065843

PATENT APPLICATION

selected as the diameter of the perforated disc ~~previously described~~. herein above. In the field of medical engineering, however, diameters ~~for applications~~, the diameter of the perforated disc ~~ranging~~ can be selected to be between about 3 and 30 mm, and preferably of the order of 8 mm, have proved advantageous or approximately 8 mm.

[0028] To ~~set the~~ select a spray pattern of the exemplary high frequency atomising ~~atomizing~~ device according to the invention, the spray mist produced can be modulated with using a controllable air or inert gas jet, where the inert gas jet at the same time providing the can also provide an explosion protection ~~of~~ for the exemplary device. The air or inert gas jet ~~for modulating the spray pattern~~ is can be produced by enclosing the entire atomising unit exemplary atomizing arrangement, including the ultrasonic atomiser, ~~with~~ atomizer, within a housing that is open on one side, ~~which~~ where the housing has may be provided with a connection for a controllable inert gas supply, and ~~obviously~~ a connection for the coating fluid. In this manner, so that the inert gas supplied to the inside of the housing via the inert gas connection of the housing is able to escape focussed in the manner of a jet at one can be focused and escape from an opening of the housing, as a result of which in the form of a jet. This inert gas jet required for modulating can be used to modulate the spray pattern ~~is generated~~.

[0029] By arranging the resonance body of the ultrasonic atomiser ~~atomizer~~, e.g., either immediately indirectly within one opening of the housing or ~~in the~~

WO 2005/065843

PATENT APPLICATION

~~approximate area of~~close to the housing opening, the spray pattern of the high frequency ~~atomising~~atomizing device can be modulated by the inert gas jet ~~produced~~. The ~~natural~~ volumetric flow of the spray mist can, for example, be accelerated by controlling the inert gas supply. ~~Furthermore, the~~ The spray jet can also be directed and ~~stabilised~~stabilized by the inert gas jet ~~produced~~, ~~also enabling the, which can~~ enable a widening of the spray cone to be adjusted. Because of support provided by the inert gas ~~support~~, the spreading angle of the spray cone of the ~~atomised~~atomized coating material can be varied from about 0° to 180°, ~~preference being given to and~~ spray jet cones ~~with an~~having a spreading angle of approximately 30° ~~for~~may be used to coat smaller components such as, for example ~~the~~ substrates ~~to be found~~used in the field of medical engineering.

[0030] ~~In order to be able to influence~~Characteristics of the spray jet ~~characteristic~~can be influenced more effectively, for example, by providing one of the openings of the housing ~~may be provided with an inert gas nozzle through which the~~ inert gas supplied ~~via the~~by an inert gas feed ~~escapes~~can escape as a carrier medium ~~for spray jet conditioning of~~to condition the spray mist. This nozzle may, for example, be designed ~~as an expanding funnel which expands outwards or~~ provided as an expanding funnel which can expand or reduce in an outward direction from the housing opening. An annular gap, ~~through which the inert gas fed to~~ the inside of the housing is able to escape, ~~is~~ can be formed between the funnel and ~~resonance body by~~the resonance body by providing the resonance body of

WO 2005/065843

PATENT APPLICATION

the ultrasonic atomiser arranged in this atomizer within the expanding or reducing funnel, and the inert gas fed to the inside of the housing can be able to escape through this gap. The width of ~~this~~ the annular gap may, for example, be varied by moving the resonance body ~~in the~~ along a longitudinal direction ~~of~~ with respect to the funnel, and/or by varying the angle of expansion of the funnel, enabling which can allow the spray jet ~~characteristic~~ characteristics to be further influenced.

[0031] In contrast to ~~pressurised~~ conventional pressurized spray nozzles ~~of~~ prior art, the ~~characteristic~~ characteristics of the spray jet generated ~~can~~ therefore using a spray device in accordance with the exemplary embodiments of the present invention may be influenced in ~~several different~~ particular ways. For example, the spray jet may be varied not only by ~~the variations in~~ varying the volumetric flow of the coating fluid, but also by adjusting ~~the~~ a working frequency of the ~~atomising unit~~ atomizing arrangement in the ultrasonic range, e.g., between about 20 kHz to 3 MHz, preferably 20 to 200 kHz. A further possibility of varying the spray jet ~~characteristic~~ also consists in varying the energy supply to the atomising unit, which normally ranges from approximately 0.01 to 100 W. A fourth possibility of varying the spray jet consists, as already described, in influence the spray jet and 3 MHz, preferably about 20 to 200 kHz. The spray jet characteristics may also be varied, for example, by varying the energy provided to the atomizing arrangement, which can range from between about 0.01 W and 100 W. The spray jet can be further varied, as described above, by adjusting the inert gas supply supplied to the housing in which the ~~atomising~~

WO 2005/065843

PATENT APPLICATION

~~unit is installed. A further possibility of influencing the spray jet characteristic consists, as already discussed, in influencing the spray jet by varying~~atomizing arrangement is provided.
Another way to vary the spray jet characteristics can be to vary the annular gap formed between the resonance body and the funnel expanding in the~~funnel in a~~ connection to one of the housing openings.

[0032] ~~Here there are also possibilities~~Other conventional techniques
~~that are already~~may be known from paint spraying technology ~~e.g. can be used in various combinations with the techniques described above to modify the spray characteristics and pattern including, e.g., dilution of the liquid coating, selection of solvents to be mixed with the liquid coating, removal of the nozzle from the substrate, additives, for optimising the spray pattern.~~or mixing of additives with the liquid coating.

[0033] ~~There is also a possibility of carrying out extensive~~Extensive coatings ~~in which~~can also be provided, e.g., by using a plurality of nozzles ~~and that may be arranged next to each other in a cascade fashion. Here the~~configuration. An extensive or otherwise elongated substrate can be guided past the nozzles ~~by means of~~using, e.g., a conveyor belt, or alternatively the nozzles can be guided ~~above the standing~~along a stationary substrate.

[0034] ~~It may also be preferable to provide the high~~ In further exemplary embodiments of the present invention, the exemplary high-frequency
~~atomising~~atomizing device can be provided with one or more devices, ~~or to~~

~~WO 2005/065843~~

PATENT APPLICATION

~~provide such devices on it, which generally~~arrangements that can allow adjustment of the temperature of the inert gas ~~and/or of,~~ the coating fluid and/or ~~of the~~ coating chamber, ~~for.~~ For example, a controlled or uncontrolled device~~arrangement may be provided~~ for tempering the inertised air in the application system, in which case the following principles of action may be applied: ~~heat exchanger process in the apparatus for cooling or heating~~inert air or gas in the device, which can, e.g., cool or heat the ultrasonic nozzle, the ~~inertising~~inert gas or the coating solutions, or any combination thereof, by a heat exchange mechanism.

[0035] ~~This means that it may be advantageous, in a coating process or when coating a substrate with a coating fluid, for constant, homogeneous and constant~~Constant and/or homogeneous conditions ~~to prevail~~can be provided for the coating medium, the coating fluid, ~~and/or a~~ dispersion which may be formed in different aggregate conditions throughout the ~~process.~~spray coating procedure. For example, ~~this means that the temperature of the coating fluid does~~may not change substantially ~~on the~~over a path from a storage tank to an ~~atomising unit.~~ These constant conditions ~~or~~the atomizing arrangement. Constant conditions, e.g., temperature conditions ~~could,~~ can be disturbed, for example, if the spray head or the ~~atomising unit~~atomizing arrangement is heated as a result ~~of~~in response to energy supplied when an ultrasonic spray head is used, ~~for example.~~ This heating could be transmitted to the coating fluid to be applied and ~~could heat~~result in the coatingheating of

WO 2005/065843

PATENT APPLICATION

the fluid. For example, ~~it could transpire that~~ if the exemplary atomizing arrangement is heated, the temperature can rise to the melting point of particles contained which may be present in a the coating fluid is reached on the heated atomising unit. This ~~could~~ heating can result in melting of the particles ~~and sticking of the atomising unit or,~~ which in turn could stick to the exemplary atomizing arrangement or the ultrasonic spray head. ~~This would give rise, leading to poor quality of the spray application and/or resulting coating results.~~

[0036] ~~It could also happen that~~ The heating procedure can also lead to a premature evaporation of a solvent that may be present in a coating fluid evaporates prematurely, i.e. even, where evaporation can occur before application. of the coating liquid to a substrate. This premature evaporation, ~~unless desired, could provided~~ intentionally, may also result in poor quality of the spray application and coating results. /or resulting coating.

[0037] It may therefore be advantageous to ~~set constant temperatures~~ provide an approximately constant temperature throughout ~~the a path or process of distribution of a gas or for distributing of a gas or a coating fluid.~~ An essentially constant temperature may be reached This approximately constant temperature may be provided, for example, by cooling ~~down of~~ an overheated area, e.g. an overheated atomising atomizing nozzle, by means of using a temperature setting device or, or for example, by heating a supply line system, an air or gas supply, tubes, particularly including capillary tubes, or another distribution system arrangement for the coating fluid or for particles

WO 2005/065843

PATENT APPLICATION

~~dissolved in a solvent. This heating could be necessary if the distribution system leads~~ This heating may be preferred if, e.g., the distribution system passes through a colder area. ~~By of the device which may lead to cooling of a portion of the distribution system. If such cooling occurs, for example, the conveyed coating fluid could also be cooled. The fluid, which is can be liquid under normal operating conditions, could therefore assume a become more viscous condition when cooled and obstruct or impair transfer- of the fluid.~~ Heating of the distribution system may also indirectly heat the conveyed medium and/or coating fluid ~~indirectly~~, thereby influencing the temperature of the coating fluid. ~~Direct influencing of the temperature of the coating fluid is also possible.~~

[0038] A procedure to directly influence the temperature of the coating fluid can also be performed. For example, a heating coil or a heat exchanger may be ~~installed~~ provided in or on the distribution system or it may be flushed by the coating fluid, thereby also regulating the temperature, for example, by ~~means of a control or regulating system, by that is capable of~~ either supplying or discharging heat. Heat ~~supply via~~ may also be supplied using, e.g., infrared systems or inductive systems is also possible arrangements.

[0039] In certain exemplary embodiments ~~it is also advantageous, unlike keeping the temperature of the coating fluid constant, to provide of the present invention,~~ different temperatures specifically can be provided at different points ~~in regions of~~ the distribution system. ~~Whilst in the case described above there is an interest in having as~~ Although a low a

WO 2005/065843

PATENT APPLICATION

~~temperature gradient as possible, a temperature gradient is desirable in the latter case. This is advantageous, for example, in coatings, particularly coating fluids, may be preferable in certain configurations, as described above, a temperature gradient may be desired in certain procedures. For example, temperature variations may be desired when applying certain coatings such as, e.g., coating fluids or dispersions whose particles~~containing particles which can be efficiently transferred in conjunction with a solvent.

[0040] In addition, ~~it may be an advantage for coating, in certain~~further exemplary embodiments, ~~for of the particles to be present in undissolved form, for which purpose the solvent must be removed. The increase in temperature, e.g. in an atomising unit according to the invention, particularly~~present invention, particles in a coating material may be present in an undissolved form, which can require removal of a solvent. An increased temperature provided in a region or portion of the exemplary atomizing arrangement, e.g., in a resonance body or a tube, allows the solvent to vaporise orcan allow a solvent to vaporize or evaporate so that the particles ~~are~~can be present in an undissolved form on the spray head or ~~atomising unit~~atomizing arrangement or on the sound head. The coating fluid can ~~therefore be conveyed in this embodiment of the invention by~~from a storage container as far as an atomising unit ~~under~~to an atomizing assembly at temperatures which ~~leave the~~can maintain particles dissolved in the solvent. This ~~facilitates~~to facilitate transfer. ~~The~~of the fluid. An increased temperature ~~of the atomising unit then allows the solvent to vaporise~~provided at the

WO 2005/065843

PATENT APPLICATION

atomizing arrangement can allow the solvent to vaporize in the region of the atomizing unit or ultrasonic atomiser~~atomizing arrangement or the ultrasonic atomizer~~, so that the particles transferred to the ultrasonic ~~atomiser~~atomizer or sound head ~~are~~may be present in undissolved form. ~~They may, and therefore may~~ be applied more efficiently.

[0041] Other temperature gradients may ~~in turn be advantageous~~used for ~~other~~particular applications, coating fluids and/or dispersions. ~~These~~ For example, these temperature gradients may be ~~set by means of temperature setting devices and by means of a~~providing using, e.g., temperature setting arrangements or process temperature control device controlling the conditions that can bedevices, which may control predetermined ~~for a coating process.~~conditions for a particular coating process.

[0042] Moreover, ~~the~~The temperature and/or coating characteristiccharacteristics of the coating fluid ~~or, the~~ spreading capacity of a coating fluid, and/or ~~the~~ droplets or particles formed by ~~it~~a coating fluid, can also be preferably influenced ~~according to the invention by adapting~~by varying the temperature of an inert gas added in an air flow. This ~~adaptation~~variation in temperature may be carried out~~achieved~~ directly or indirectly.

[0043] Furthermore, ~~it may be preferable according to the invention to temper completely or partially a space~~A region or area around the substrate or, if ~~necessary~~desired, the coating chamber ~~correspondingly~~.

~~WO 2005/065843~~

PATENT APPLICATION

~~For this purpose, can be tempered completely or partially. To achieve this, a hot spray mist, formed from atomised, e.g., atomized hot particles, can be mixed with a cooled inert gas or distributed in a cooled coating chamber, so that it cools, thereby improving the adhesivity of the particles on a substrate, for example. This may therefore influence the temperature of the inertised air or the inertised gas, i.e. the~~adhesion of the particles to a substrate. This can affect the temperature of the inert air or the inert gas, e.g., a mixture of coating fluid with inert gas or air.

[0044] ~~The more temperature setting devices are installed distributed~~Increasingly precise temperature gradients can be provided, and more flexible conditions can be used in a coating process, by distributing more temperature setting arrangements within and over the distribution system for the coating fluid or inert gas, the air or in the coating chamber, the more precisely temperature gradients can be adapted and the more flexibly conditions can be set for a coating process, inert gas and/or air, and/or in the coating chamber. Settings for the various temperature setting arrangements may be linked to a microprocessor, thus allowing coordination of the control of these arrangements in a coating procedure.

[0045]

[0046] ~~It is also possible, and preferable if necessary, to link the settings to a microprocessor, and therefore to store~~

WO 2005/065843

PATENT APPLICATION

~~certain process samples and coordinate, preferably control, different temperature setting devices.~~

[0047] ~~To obtain a spray pattern that is optimum for the application in question, the previously explained~~Various ~~components which may contribute to varying the~~characteristics of a spray jet ~~characteristic are, such as those descried herein above, may be controlled by means of, e.g., a microprocessor.~~
~~The~~to generate a spray pattern that may be preferable for a particular procedure. For example, the volumetric flow of the coating fluid generatedprovided ~~by the~~a ~~proportioning pump, as well as the~~a ~~working frequency and/or energy supply of~~supplied to ~~the ultrasonic atomiser, is therefore~~atomizer can be ~~controlled with a microprocessor.~~
~~This~~The ~~microprocessor is~~may also be ~~used for controlling the~~to control a flow of an inert gas supplysupplied ~~to the spray jet conditioning system, according to the flow rate.~~
~~The individual factors which may influence the spray pattern may~~can be set or controlled ~~by the microprocessor and are dependent on each other, and these factors may be~~
interdependent.

[0048] ~~Although the coating result for~~Characteristics of a coating applied ~~to a substrate to be coated can be substantially improved solely with the~~using an ~~ultrasonic atomiser according to the~~atomizer in accordance with the exemplary embodiments of the present ~~invention, as described above, this result, which is already satisfactory in itself,~~herein above. The coating quality can be improved even further by, for example, retaining the substrate to be coated inside the spray mist with a substrate holder during the coating process in a position that is

WO 2005/065843

PATENT APPLICATION

~~favourable for coating. Preferably this substrate holder is~~
~~suitable for subjecting the substrate retained in the substrate~~
~~holder~~favorable for coating using a substrate holder. The substrate holder can be configured
to provide, e.g., three translational and three rotational degrees of freedom of movement of the
substrate, in the region of the spray mist produced, to three different
~~translatory and three different rotatory degrees of freedom of~~
~~movement. In particular, For example, the substrate can be moved with the~~
~~substrate holder in the region of the spray mist in three different coordinate directions,~~
~~thus enabling~~using the substrate holder, which may allow the substrate to be coated
highly uniformly with a coating fluid.

[0049] According to yet a further aspect exemplary embodiment of this
~~invention, the coating result of a substrate that can be~~
~~achieved with the high frequency atomising~~the present invention, a coating
applied to a substrate using the high-frequency atomizing device according to the
~~invention~~described herein can be further improved in that, ~~unlike coating~~
~~methods of prior art, the substrate need not if, e.g., the substrate does not~~
need to be removed from the substrate holder following the coating process for drying purposes,
for example, so that it can be hardened in a drying oven, but in that the high
~~frequency atomising device itself comprises a drying device~~
~~which is.~~ This can be achieved, for example, by providing a high-frequency atomizing
device which includes a drying arrangement that can be suitable for drying, hardening or cross-
linking the spray mist coat formed on the substrate, ~~or for hardening or cross-~~

WO 2005/065843

PATENT APPLICATION

~~linking it. For instance, it is possible by means of this drying device to dry the same even during the coating process simultaneously with the application of the coating film. For example, it can be possible to dry or cure an applied coating film using the drying arrangement during the coating process, while the coating film is being applied.~~

[0050] ~~This can be achieved, for example, by loading the~~Drying of the coating film can be achieved, for example, by heating a freshly -coated substrate with a heat flow even during the coating process. For this purpose the heat source may compriseusing a heat source during the coating process. A heat source may include, for example, a heating system which is in turn, just as the atomising unit, ismay be enclosed by a heating housing that can be open on one side, which has and which includes a controllable inert gas supply for generating a flow of hot air flow. The inert or gas. The inert gas fed to the heating housing iscan be heated in the heating housing and escapes from it via a nozzle arranged on one of the openings of the heating housing, and can be fed specifically to the substrate by means of the nozzle.escape from it through a nozzle arranged on an opening of the heating housing, and the heated gas can be directed towards the substrate using the nozzle.

[0051] ~~Another possibility of drying the coating film formed on the substrate consists in first fully sealing the coating of the substrate,~~The coating film can also be dried, e.g., by first applying a full coating onto

WO 2005/065843

PATENT APPLICATION

the substrate, and then moving the fully coated substrate, coated substrate, together
with the substrate holder, ~~into the region of~~ proximate to the escape opening of the
heating housing nozzle, so that ~~the drying or hardening of the coating film~~
~~is carried out~~ drying and/or hardening of the coating film can be achieved after the
coating process.

[0052] Obviously it is also possible, instead of the In addition to
~~drying based on~~ the applied coating using thermal convection, ~~to dry~~ the coating film
formed on the substrate may also be dried indirectly by radiation, particularly including
infrared radiation. ~~This drying by means of thermal radiation may prove~~
~~particularly advantageous in that the~~ The use of thermal radiation can provide
a heat source for generating the thermal radiation can be arranged to be located outside the
area of the high frequency atomising atomizing device ~~where there is, which can~~
reduce a risk of explosion. For example, the heat source for generating ~~a~~ the thermal radiation
may be arranged outside of a housing in which are arranged the atomising
~~unit~~ which may enclose the exemplary atomizing arrangement and the positionable substrate
holder ~~in order to avoid~~. This configuration can prevent or reduce cross flows of gases
that ~~normally may~~ have a detrimental effect on ~~an~~ a homogeneous spray pattern. ~~This~~ The
housing can therefore ~~protects~~ protect the spray pattern generated with the atomising
~~unit~~ by the exemplary atomizing arrangement before any cross flow ~~exerts~~ of gases can exert
a possible negative influence such as, e.g., disrupting or distorting the spray pattern, so that the
coating result and its quality can be improved ~~still further by the housing,~~

WO 2005/065843

PATENT APPLICATION

~~which surrounds at least the atomising unit and the positionable substrate holder~~further.

[0053] ~~A~~In a further exemplary embodiment of the present invention, a suction device can be provided ~~which is suitable for~~capable of collecting and ~~sucking~~drawing off the overspray, ~~i.e.g., the quantity of atomised~~atomized coating fluid which ~~is~~may be sprayed past the substrate to be coated, ~~can also be arranged in this.~~ The suction device can be provided within the housing, for example, ~~to ensure so that this~~the overspray is not lost and ~~can~~allowing it to be fed back to the ~~atomising unit~~atomizing arrangement, for example, ~~for atomisation.~~ Obviously ~~this~~to be atomized again. The suction device, as well as the substrate holder, can also be controlled by the ~~above mentioned~~ microprocessor described herein above, so that the spray characteristic of the ~~atomising~~atomizing device can also be influenced, for example, by manipulation of the suction flow ~~and, e.g., by generating a vacuum.~~ ~~On the other hand, by~~ Further, controlling the substrate holder ~~by means of the~~using a microprocessor ~~it is possible to retain~~can allow the substrate to be coated ~~constantly in an optimum~~to be maintained in an optimal or preferred position in the region of the spray jet produced, ~~depending on all the~~where this position may further depend on other process parameters.

[0054] ~~In addition freeze~~Freeze drying, vacuum drying and/or flow drying in the air or gas flow, ~~by means of~~using suitable drying devices ~~in the arrangements described above, may be used instead of the above mentioned heat~~

WO-2005/065843

PATENT APPLICATION

~~drying processes. The person skilled in the art will in this case select the suitable drying device for each coating and drying task., may be used to dry or cure the applied coating. A suitable drying technique and an arrangement that is capable of performing it can be selected and provided for each desired coating and drying task.~~

[0055] ~~If drying~~Drying, hardening and/or cross-linking are carried out within the scope of this invention, these operations are understood generally tomay involve the transition of the coating fluid from the liquid to the solid state, but the person skilled and experienced in the field of coating technology is able to deduce the exact significance of these possibilities which have been cumulatively summarised.The treatment of an applied coating selected for a specific coating procedure can depend, e.g., on the coating material used and other process parameters.

[0056] ~~Emulsions~~For example, emulsions, suspensions and/or solutions of solid or liquid substances in suitable solvents are ~~considered~~may be used as coating fluid. ~~For example, solutions~~fluids. Solutions, suspensions, dispersions or emulsions of one or more active substances or active substance precursors provided in a suitable solvent may be atomised, but so ~~may~~atomized, and undiluted liquid active substances. ~~In addition~~ may also be atomized. Further, solutions, emulsions and/or suspensions or dispersions of one or more polymeric or non-polymeric organic or inorganic substances, or any mixtures thereof, ~~if necessary~~optionally together with cross-linking agents, as well as

WO 2005/065843

PATENT APPLICATION

~~reacting multicomponent compounds, can also be atomised, the latter subject to the provision of~~atomized. Reacting multicomponent compounds may use a suitable drying and/or setting mechanism or an adequate pot life, to avoid reaction and setting ~~inside the atomising device. Furthermore it is particularly preferable to use such coating materials, supplied from~~of the compounds inside the exemplary atomizing device. Coating materials provided, e.g., in solutions, dispersions, suspensions or emulsions, ~~which may contain particles selected from~~that can include polymeric, non-polymeric, organic or inorganic or mixed inorganic-organic or composite particles, or any mixtures thereof. ~~Preferred particles are micro-~~Microparticles and nanoparticles- may also be used. Examples of polymeric particles ~~are~~include, e.g., PMMA, PLA, proteins, etc., ~~examples~~ Examples of non-polymeric particles ~~are~~can include, but are not limited to metals, metal oxides, metal carbides, metal nitrides, metal oxynitrides, metal carbonitrides, metal oxycarbides, metal oxynitrides, metal oxycarbonitrides, metal hydrides, metal alkoxides, metal halogens, inorganic or organic metal salts. ~~Also preferred are magnetic particles, examples of which are~~ Magnetic particles that may also be used include, but are not limited to, iron, cobalt, nickel, manganese or mixtures thereof, for example, iron-platinum mixtures, or ~~as examples of magnetic metal oxides, iron oxide and/or ferrites.~~ ~~Examples of non-~~ Non-polymeric particles are also that may be used include, e.g., soot species and other nanomorphous carbon species, such as graphite, diamond, nanotubes, fullerenes and the like. ~~Of particular preference are also particles~~ Particles which are ~~supplied~~provided from sols and gels may also be used.

WO 2005/065843

PATENT APPLICATION

[0057] Melts of thermoplastic coating substances, e.g., tar, may also be used.—In addition, the use of Other coating substances that may be used can be based on dyes and varnishes, organic polymers, duro- and thermoplastics, with fibre and may further contain fiber constituents such as cellulose, glass, stone or carbon ~~fibres~~ fibers, and polymer ~~fibres~~ fibers with organic and inorganic additives, and ~~also or~~ catalysts, ~~is also preferred according to the invention. Usable and.~~ Other suitable coating substances within the scope of this invention are disclosed in DE 103 24 415, in the section headed "Polymer Films", and are therefore fully incorporated in this disclosure. are described, e.g., in German Patent Application DE 103 24 415.

[0058] The term "active substances" ~~is also understood to include, according to the invention,~~ can refer to pharmacologically active substances such as drugs, medicinal products, or pharmaceutical products, ~~but also~~ as well as microorganisms, living organic cell material, enzymes and ~~also~~ biocompatible inorganic or organic substances. The term "active substance precursor" ~~refers~~ can refer to ~~substances~~ a substance or ~~mixtures~~ a mixture of substances which ~~are~~ can be converted to active substances of the type mentioned above after application ~~on~~ such as those described above being applied onto an implant to be coated by means of using thermal, mechanical, chemical or biological ~~processes~~ procedures.

[0059] Molten active substances, or active substances dissolved, suspended or dispersed in melts, may also be applied by the exemplary atomizing device ~~according to the~~

WO-2005/065843

PATENT APPLICATION

~~inventions described herein~~, as well as those which are present in special forms of supply that active substances which can be suspended, dispersed or emulsified such as, for example, active substances encapsulated in polymers. In ~~one specific~~ another exemplary embodiment of the present invention, the distribution of the coating solution or of components of the coating solution, and ~~in particular embodiments also~~ or the geometrical orientation, e.g. of particles with magnetic properties or conductive properties, ~~is specifically~~ can be influenced by ~~the~~ using an anode and pole plate ~~system~~ arrangement that is based on magnetic and/or dielectric principles of action, ~~in which case where~~ the anode and pole plate ~~system is designed~~ arrangement may be provided with one or more channels and ~~its~~ a spatial alignment that can be varied.

[0060] Furthermore, ~~the~~ An electrode or electrostatic system, ~~with associated~~ arrangement, which may include activation electronics and an energy supply, ~~may form~~ source, can be provided as an integral part of the exemplary atomizing device, ~~in a preferred embodiment, and configured~~ so that it ~~specifically influences~~ can influence the distribution, charging, alignment and/or morphology of coating solutions and/or their constituents ~~with~~ using variable magnetic and ~~ionisation~~ or ionization fields.

[0061] Particles, ~~particularly including~~ movable or flying particles or droplets, ~~are~~ can be influenced by the crossing of electrical or magnetic fields. In ~~preferred~~ exemplary embodiments ~~according to~~ of the present invention ~~they are~~, particles can be used that may be electrically charged or ~~ionised~~ ionized as they cross electrical or magnetic fields provided for this purpose, or ~~are~~ which may otherwise be

WO 2005/065843

PATENT APPLICATION

influenced by an interaction ~~with such fields.~~ For example, ~~the~~ mutual alignment of particles may ~~vary~~ be varied. A variation of alignment ~~is caused~~ can be produced, e.g., by ~~the~~ magnetic field, particularly ~~in the case of ferrite containing particles~~ particularly preferred according to the invention. if the particles used contain ferrite.

[0062] ~~Variations~~ Ionization, electrical charging or variation in the mutual alignment of the particles ~~to be applied, according to the invention, or ionisation of the particles or electrical charging, give rise to~~ particles being applied can generate an extremely uniform distribution of a coating film or a coating fluid. Particles orientated in ~~this~~ such a manner, particularly including nanoparticles, may have better adhesion to a substrate. Moreover, ~~the drying process according to the invention is~~ a subsequent or simultaneous drying procedure can be accelerated and improved by the uniform particle alignment and ~~influencing of the~~ associated morphology.

[0063] ~~It is therefore advantageous to influence coating~~ Coating fluids, particularly including spray mists or droplets formed from them, ~~by means of~~ therefrom, can thus be influenced by electrical and/or magnetic fields, ~~which are preferred according to the invention. The fields here may be,~~ Fields that may be used can include, e.g., electro- or magnetostatic fields, or time-variant varying fields that can be modulated with ~~by~~ frequency patterns. The ~~influencing~~ influence of the electrical or magnetic fields preferred according to

WO 2005/065843

PATENT APPLICATION

~~the invention may take place~~may occur during the flight of the particles or the spray mist being applied, ~~but or~~ it may also ~~take place~~occur during or after deposition of the coating on the substrate. The ~~influence~~influence of the electrical or magnetic fields may take place simultaneously or it can be staggered in time. ~~Moreover~~ Further, a multi-channel influence, ~~i.e.g., an influence caused~~generated by a plurality of devices ~~to be~~arrangements provided according to the invention for ~~generating~~to generate electrical and/or magnetic fields, ~~and one~~ which can also act in different spatial planes, ~~is particularly preferable in certain embodiments~~can also be used.

[0064] ~~For this purpose electrical~~Electrical fields can be generated by means of electrode, anode and/or pole plate ~~systems~~arrangements suitably ~~arranged~~configured in the atomizing device according to the ~~invention~~described herein. These arrangements may, if necessary, be supplied with high voltage (HV). The ~~course~~geometry of the fields and their intensity may be influenced by the shape of the electrodes.

[0065] Magnetic fields may, for example, be generated by means of ~~electro~~electromagnets or permanent magnets suitably arranged in the atomizing device according to the invention, and in the ~~case~~described herein. The intensity and geometry of the magnetic fields ~~too, the intensity and course of the fields are~~may be influenced by the shape of the magnets used.

WO 2005/065843

PATENT APPLICATION

[0066] ~~It is advantageous not merely to generate electro~~As an alternative to generating electrostatic or magnetostatic fields. The activation and modulation of the fields preferred according to the invention, electric and/or magnetic fields can be activated and/or modulated with certain frequency patterns, or and/or by a time variation in the varying intensity, which can influence the wetting behaviourbehavior of the coating fluid and the way in which the spray mist is deposited on the substrate.

[0067] ~~The system preferred according to the invention for generating a~~A continuous or time-variantvarying magnetic field consists ofcan be generated, e.g., using a magnet, preferablywhich may be an electromagnet that can be modulated in frequency and amplitudes by means ofor amplitude using microprocessor control, which. The magnet iscan be provided with pole shoes advantageously arranged geometrically. Furthermore, the entire arrangementarranged in a suitable geometric configuration. An arrangement that includes the magnet can also be moved spatially varied by microprocessor control in relation to the substrate to be coated. The system for generating a modulable LF-HF field consists essentially of, e.g., using a microprocessor to control the movement. An exemplary arrangement provided for generating a modulated low-frequency/high-frequency field can include, e.g., a microprocessor control arrangement for generating frequency and amplitude samples, and two or more electrodes, which may be aligned

WO 2005/065843

PATENT APPLICATION

axially or radially ~~so that they are spatially variable~~ and which may be moveable, according to the specific coating application.

[0068] ~~Suitable solvents~~ Solvents that may be suitable for use in coating fluids, provided in the form of solutions, suspensions or emulsions, can include, for example, alcohols ~~and/or~~, ethers and/or hydrocarbons such as, e.g., methanol, ethanol, n-propanol, isopropanol, butoxydiglycol, butoxyethanol, butoxyisopropanol, butoxypropanol, n-butyl-alcohol, t-butyl-alcohol, butylenes glycol, butyl octanol, diethylene glycol, dimethoxydiglycol, dimethyl ether, dipropylene glycol, ethoxydiglycol, ethoxyethanol, ethylhexane diol, glycol, hexane diol, 1,2,6-hexane triol, hexyl alcohol, hexylene glycol, isobutoxypropanol, isopentyl diol, 3-methoxybutanol, methoxydiglycol, methoxyethanol, methoxyisopropanol, methoxymethyl butanol, methoxy PEG-10, methylal, methyl-hexyl ether, methylpropane diol, neopentyl glycol, PEG-4, PEG-6, PEG-7, PEG-7, PEG-9, PEG-6-methylether, pentylene glycol, PPG-7, PPG-2-buteth-3, PPG-2 butyl ether, PPG-3 butyl ether, PPG-2 methyl ether, PPG-3 methyl ether, PPG-2 propyl ether, propane diol, propylene glycol, propylene glycol-butyl ether, propylene glycol-propyl ether, tetrahydrofuran, trimethylhexanol, phenol, benzol, toluene, xylol; ~~and also/or~~ water, if necessary optionally provided in a mixture with dispersion aids, as well as any mixtures or combinations of the above.

[0069] ~~With the device according to the~~ In certain exemplary embodiments of the present invention, the surface of the ~~object~~ substrate to be coated can be partially or, essentially, fully completely coated, or even coated many times. ~~Multiple coating is carried out by the multiple use of the~~

WO 2005/065843

PATENT APPLICATION

~~atomising device in separate process steps,~~ it may be coated with multiple layers. Multiple coatings can be provided by using the atomizing device described herein in separate consecutive procedures and, if necessary, drying steps may be applied after each ~~coating process.~~ individual coating procedures.

[0070]

[0071] ~~BRIEF DESCRIPTION OF THE DRAWINGS~~

[0072]

[0073] ~~Exemplary embodiments of this invention are described in greater detail in the following, with reference to the attached drawings, for a better understanding and for further explanation of the invention. The person skilled in the art is aware in this case that all the features described in the following can be applied and generalised, within the field of this invention, for all embodiments described and conceivable, as well as their combinations.~~

[0074]

[0075] ~~Fig. 1 is a schematised system sketch of the high frequency~~

[0076] ~~atomising device according to the invention;~~

[0077]

[0078] ~~Fig. 2 shows a section through the resonance body according~~

[0079] ~~to the invention, which widens into the shape of a~~

WO 2005/065843

PATENT APPLICATION

[0080] ~~trumpet,~~

[0081]

[0082] ~~Fig. 3 is a schematised system sketch of a preferred embodiment of the high frequency atomising device according to the invention, with temperature setting devices and devices for generating electrical and magnetic fields.~~

~~In the figures the same parts are identified with corresponding reference symbols.~~

[0083] For example, complete closed coatings having a thickness of approximately 1 nm to approximately 1 mm, or thicker, can be produced using the spray device according to exemplary embodiments of the present invention. The exemplary coatings can be produced having a thickness between about 1 nm and 100 μ m, or from about 1 nm to 10 μ m, or between about 1 nm and 1 μ m. The exemplary coatings can also be produced which have a thickness between about 10 nm and 1 μ m, or between about 1 nm and 10 nm.

[0084] Fig. 1 shows a schematic illustration of an exemplary embodiment of the high frequency atomising device according to the invention in a schematised representation. As may be deduced from Fig. 1, the high frequency atomising device shown schematically in it comprises, among other things, an atomising unit 1, which is suitable for atomising a high-frequency atomizing device in accordance with the present invention. The exemplary high-frequency atomizing device can include an atomizing arrangement 1, which may be suitable for atomizing a coating fluid fed to it.~~Atomising~~

WO 2005/065843

PATENT APPLICATION

~~unit~~ The atomizing arrangement 1 may, for example, be an ultrasonic ~~atomiser~~ atomizer which can be excited, for example, ~~with~~ by a piezoelectric element to generate high frequency vibrations. ~~Atomising unit 1 can be loaded with~~ A coating fluid, which may be stored in a storage tank 5, can be provided to the atomizing arrangement 1 by a precision proportioning pump 4 with a coating fluid which is retained in a storage tank 5 for storing the coating fluid. As may be deduced from Fig. 1, the coating fluid is pumped from storage tank 5 with 4. The coating fluid can be pumped from the storage tank 5 by the precision pump 4 via a system of tubes to atomising unit 1. the exemplary atomizing arrangement 1. The coating fluid that is fed in this way to ~~atomising unit 1~~ is excited by ~~atomising unit~~ manner to the exemplary atomizing arrangement 1 can be excited by the exemplary atomizing arrangement 1 to generate high frequency vibrations, and is can be conveyed further in the direction of a resonance body 2 by the a continuous volumetric flow generated by the precision proportioning pump 4 via a capillary tube 17. ~~Instead of exciting the~~ The coating fluid can be excited directly by means of the ~~atomising unit~~ using the atomizing arrangement 1 to generate vibrations as the fluid passes it, it is obviously also possible to excite only resonance body 2, which in turn then excites through it. Alternatively, the resonance body 2 can be excited, which in turn can excite the coating fluid to generate produce vibrations as soon as it has reached therein as the fluid reaches the resonance body 2.

WO 2005/065843

PATENT APPLICATION

[0085] ~~Resonance body 2, including~~ A cross-sectional enlarged illustration of
the exemplary resonance body 2, together with the exemplary capillary tube 17, is shown in Fig.
~~2 on an enlarged scale. As may be deduced from Fig. 2, capillary~~
~~tube 17 is~~ 2. The capillary tube 17 can be incorporated into the resonance body
~~denoted by the reference number 2, so~~ such that no discontinuities or jumps
are ~~produced~~ present in the transition between the end of capillary tube 17 and
~~the~~ the capillary tube 17 and an expanding inner face 4 of resonance body 2. 18 of
the resonance body 2. The coating material which may be excited to generate high -frequency
vibrations by means of atomising unit 1 is fed via capillary tube 17
to resonance body 2, and is then the exemplary atomizing arrangement 1 can be
fed by the capillary tube 17 to the resonance body 2, and may then be distributed on the inner
horn-shaped face of horn 18 of 18 of the resonance body 2 in a thin coat layer, and is
~~then~~ can then be further dispersed on a perforated disc 22, as indicated by the arrows, which
~~horn widens into the shape of a trumpet in Fig. 2, where the horn-shaped face~~
may widen into a trumpet-like shape.

[0086] ~~Resonance~~ The resonance body 2, which ~~in turn is~~ may also be excited to
generate high -frequency vibrations, ~~reinforces~~ can reinforce the vibrations induced ~~into~~ in
the coating fluid, ~~causing. This may cause~~ concentric capillary waves to be formed in the
coating fluid, which is distributed on ~~horn 18 that widens into the shape of a~~
~~trumpet. the horn-shaped face 18.~~ Because of the inertia of the mass of the coating fluid that
can be excited to generate capillary waves, very fine droplets of the coating fluid may separate

WO 2005/065843

PATENT APPLICATION

from the vibration curves of the capillary waves, ~~giving rise~~ which can lead to the formation of a spray mist.

[0087] ~~In addition to the advantageous embodiment of~~ The resonance body 2, ~~with~~ 2 can include the inner horn-shaped face 18 that widens into the shape of a trumpet, ~~the~~ like shape, as shown in Fig. 2. A transition between the ~~from a feed line to the atomising~~ an atomizing tip and the surface thereof, ~~disclosed in US~~ such as that described, e.g., in U.S. Patent No. 4,655,393, is also indicated as a comparison in Fig. 2 by a dotted line and identified by the reference number 19. As can be deduced from this, the transition ~~shown for comparison purposes in Fig. 2, and is indicated by a dashed line 19 therein. The transition 19 between the feed line and the surface of the atomising~~ atomizing tip has a discontinuity in the form of an edge or corner, which prevents ~~may prevent~~ the coating fluid from being dispersed uniformly on the surface of the atomising ~~atomizing tip. This in turn causes~~ can then cause coarser drops to become detached from the edge-like transition, ~~19, in an uncontrolled fashion, resulting in the impairment of the coating result already explained. However, counteracting this risk of impairment of the coating result due to detachment of larger droplets was, among other things, an object of this invention, an object which is achieved, among other things, by the continuously expanding horn shape of resonance body 2 ~~manner, which may result in a reduction in quality of the coating as described above. This reduction in coating~~~~

WO 2005/065843

PATENT APPLICATION

quality can be avoided or minimized by using the exemplary atomizing device described herein,
which can include the resonance body 2 which has inner horn-shaped face 18, as shown in Fig. 2.

[0088] ~~As may further be deduced from~~The atomizing arrangement 1 shown
in Fig. 1, atomising unit 1 may be surrounded by a housing 16, which can be open
on one side. Resonance The resonance body 2 ismay be arranged in oneproximate to an
opening of the openings of housing 16. Air A nozzle/ 3, through which air, gas
nozzle/or inert gas nozzle 3 connectsmay flow, can connect directly to one of the
openings of the housing 16 in the form of an expanding funnel, so that an annular gap ismay
be formed between ~~the atomiser~~an atomizer plate of the resonance body 2 and the
expanding funnel of ~~inert gas~~the nozzle 3. ~~Housing~~ The housing 16, in which
~~atomising unit 1 is arranged,~~ the exemplary atomizing arrangement 1 is
situated, can be supplied with a controllable inert gas volumetric flow, ~~whose volume is~~
~~set by means of.~~ The flow rate of this gas may be configured or established using a
control valve 12, which ~~is~~can be controlled, for example, by a microprocessor 7. ~~In the~~
~~preferred case~~ The microprocessor 7 can also controlcontrol, e.g., the operating
frequency of ~~atomising unit~~the exemplary atomizing arrangement 1 and/or the volumetric
flow ~~of~~provided by the precision proportioning pump 4, which ~~supplies atomising~~
~~unit~~can supply the atomizing arrangement 1 with coating meansfluid from the storage tank 5.

[0089] ~~The inert gas with,~~ which may be provided to the interior of the housing 16
~~is loaded is~~16, can be dispersed in the housing 16 and ~~escapes~~escape from one of the
openings of the housing 16 through the annular gap (which ismay be formed between the

WO 2005/065843

PATENT APPLICATION

~~atomiser~~atomizer plate of the resonance body 2 and the expanding funnel ~~of~~3). By using such inert gas 3. As a result of this escape of inert gas ~~from which can~~ escape from the housing 16, the spray mist which has separated from the resonance body 2 ~~excited to generate high frequency vibrations~~ can be modulated in ~~hit~~to form various spray pattern patterns. The spray pattern can be varied in different ways, ~~particularly in~~ conjunction with the inert gas nozzle 3 and the inert gas escaping through the annular gap. For example, the volumetric flow of the spray jet can be accelerated by varying the inert gas flow, or the spray jet can be widened or reduced by varying the opening angle of the funnel of the inert gas nozzle 3.

[0090] ~~Substrate~~The substrate 14 can be positioned by a substrate holder 8, by means of ~~the~~using a workpiece clamping device 9 ~~belonging to that may be associated with~~ the substrate holder, ~~underneath~~ 8, beneath the resonance body 2 of the exemplary high frequency ~~atomising device according to the invention. As~~ denoted here by the references x, y, z and r, atomizing device as shown in Fig. 1. ~~The substrate holder 8 is able to subject~~can be configured to controllably move the substrate 14 to ~~in~~ three different translatorytranslational movement directions x, y and z, and one ~~rotatory~~rotational movement r. ~~Substrate~~direction r shown in Fig. 1. The substrate 14 can therefore be ~~retained~~held and moved ~~constantly in~~controllably to a suitable position inside the spray mist by ~~means of~~using the substrate holder 8 throughout the coating process. ~~For~~ The substrate holder 8 may be controlled by the microprocessor 7 which can allow, for example, monitoring of the presentcurrent position of the substrate 14

~~WO 2005/065843~~PATENT APPLICATION

~~and to vary~~variation of the position of the substrate 14 within the spray mist, ~~substrate holder 8 is controlled by.~~ The microprocessor 7, ~~for example, with which all~~7 can also be used, e.g., to monitor all of the processes and parameters of the spray device ~~according to the invention are monitored.~~

[0091] ~~In the region inside substrate 14 a~~A controllable vacuum suction system 10 can be ~~arranged for~~provided near the substrate 14, for example, to further condition the spray jet ~~conditioning and for sucking off the overspray, the associated suction pump of which system is~~and/or to draw in the overspray. A suction pump that may be included in the controllable vacuum suction system 10 can also controlled by the microprocessor 7.

[0092] The exemplary high-frequency atomizing device shown in Fig. 1 can also include a drying arrangement 6 which can include, e.g., a heat source, which may be configured to dry or harden the freshly coated substrate 14. The drying arrangement 6 can include, for example, a heating system that may be controllable by the microprocessor 7, and it may be provided in a housing 20 that can be open on one side. The interior of the housing 20 may be provided with an adjustable inert gas volumetric flow, similar to the housing 16 surrounding the atomizing arrangement 1, where the flow can be regulating using a control valve 13. The control valve 13 may also be controlled by the microprocessor 7 as a function of some or all of the process parameters.

[0093] ~~The high frequency atomising device according to the invention, shown in Fig. 1, also comprises a drying device 6,~~

WO 2005/065843

PATENT APPLICATION

~~e.g. a heat source, which is arranged to dry or harden the freshly coated substrate 14. Drying device 6 comprises, for example, a heating system that is preferably controllable by microprocessor 7, which system is accommodated in a housing 20 open on one side. The interior of housing 20 open on one side, as housing 16 of atomising unit 1, is loaded with an adjustable inert gas volumetric flow which is set by means of control valve 13. Control valve 13 may in turn be controlled by microprocessor 7 as a function of all the process parameters. The inert gas volumetric flow fed to this~~the housing 20 is~~can be heated in~~within the housing 20 by the~~heat from~~provided by the heat source 6, and ~~escapes it can escape through the~~an opening in the housing 20 formed by a nozzle 21. With the heat flow thus generated the ~~The~~ freshly coated substrate 14 can be dried, but for this purpose it would have by the heat flow thus generated, but this can require the substrate 14 to be moved from the position shown in Figure 1 in the direction of ~~Fig. 1 towards the heat source 6. However, it is also possible to align~~ The nozzle 21 of the heat source 6 can also be aligned so that the film coats coating layers freshly coated ~~on~~applied to the substrate 14 ~~are~~can be dried immediately after their application to the substrate 14, e.g., in the position shown in Fig. 1.

[0094] ~~In order to~~To protect the coating ~~process~~procedure from possible cross flows or dust, ~~atomising unit~~the exemplary atomizing arrangement 1, including the housing 16 surrounding it, the drying device 6, the vacuum suction system ~~±010~~10, and ~~of~~

WO 2005/065843

PATENT APPLICATION

~~course~~ the substrate 14 itself, can each be arranged ~~in~~ within a housing 11, represented schematically here ~~by dotted lines~~. If ~~instead of a drying device 6 based on drying flow, a heat source 6 based on thermal radiation were to be used, such a drying device 6 based on thermal radiation could of course also~~ in Fig. 1 by a dashed line. If the drying arrangement 6 is used that includes a source of thermal radiation, it can optionally be arranged outside of the housing 11 in order and be configured to dry the freshly coated substrate in 14 located within the housing 11. ~~In any case it is~~ It may not be necessary to remove the substrate 14 from the workpiece clamping device 9 of the substrate holder 8 in order to dry the substrate 14 after coating due to it using the use of drying device 6, thus avoiding arrangement 6. This can avoid possible damage to the coating of the substrate 14 if it is not yet dried when it is removed from the workpiece clamping device 9.

[0095] ~~The device according to the invention may be adapted in certain embodiments for extensive~~ Extensive coating of substrates can be achieved by providing, e.g., a multiplicity of ~~atomisers~~ plurality of atomizers arranged in a cascade fashion, and guiding the substrates along them the atomizers on a conveying devices arrangement, or alternatively by guiding an atomiser cascade along the plurality of atomizers along the substrates on using a conveying device arrangement. Suitable conveying devices arrangement may include, for example, conveyor belts and the like.

WO 2005/065843

PATENT APPLICATION

[0096] Fig. 3 ~~is based essentially on the high frequency atomising devices shown in Fig. 1. Unlike Fig. 1, Fig. 3 also shows~~shows a schematic illustration of another high-frequency atomizing device in accordance with certain exemplary embodiments of the present invention. The exemplary atomizing device shown in Fig. 3 includes a process temperature control device~~arrangement~~ 27 ~~with~~connected~~and~~ first temperature setting devices 23, 25, ~~a~~ second 24 ~~and third~~ 26 ~~temperature setting device. Process~~temperature setting device 24, and a third temperature setting device 26 connected thereto. The process temperature control device 27 ~~is connected to~~arrangement 27 can be connected to the microprocessor 7 ~~and can~~, and can be configured to receive settings and/or instructions for settings from this~~the~~ microprocessor ~~for~~7 corresponding to desired process conditions for a coating process.~~procedure.~~ For example, temperature gradients of a coating fluid may ~~therefore~~ be produced or compensated for in ~~a~~the storage tank 5 and on an ~~atomising unit 1.~~the atomizing arrangement 1. Whether a temperature gradient is ~~required~~desired or is to be prevented ~~depends~~can depend on the material used as coating fluid ~~or its thermal characteristic. This enables the behaviour~~and its thermal characteristics. The process temperature control arrangement 27 can allow the behavior of the coating fluid to be influenced during transport or spraying ~~to be suitably influeneed~~thereof.

[0097] The temperature of the coating fluid in the storage tank 5 may be set ~~by means of~~using the first temperature setting device 23. ~~As the further first 25, second 24 and third 26 temperature setting device, this~~23, which is represented

~~WO 2005/065843~~

PATENT APPLICATION

~~schematically in Fig. 1 as a heating coil. However, this is also understood to be a coil, as are the other temperature setting devices 24-26. However, these temperature setting devices 23-26 can include other heat sources, such as, e.g., infrared radiators, heat exchangers, heat pumps, etc. Moreover, all each of the temperature setting devices 23-26 can also be used to extract heat and/or for cooling, in which case and thus may include, e.g., cooling units or fans can be used, for example.~~

[0098] ~~Whilst two~~ Two first temperature setting devices 23, 25 ~~for~~ are shown in Fig. 3 that can be capable of influencing the temperature of the coating fluid ~~are shown in Fig. 3, . However, any number of such first temperature setting devices may be arranged along the distribution system of the coating fluid, according to requirements. The as needed or desired. The fluid distribution system comprises essentially~~ includes the storage tank 5, the precision pump 4, atomising unit the exemplary atomizing arrangement 1 and a tube system arrangement which connects the storage tank 5 to the precision pump 4, and the precision pump 4 to atomising unit 1. In particular, the exemplary atomizing arrangement 1. For example, the capillary tube 17 and the resonance body 2 are also incorporated. Each of these elements can also be part of the distribution system. Each element of the distribution system can be provided separately with a first temperature setting device. The action of the temperature setting devices can be exerted directly, i.e. directly on 23-26 can, e.g., heat or cool the coating fluid directly. An example of direct action of heating of the coating fluid in the storage tank 5 by

WO 2005/065843

PATENT APPLICATION

~~the~~ first temperature setting device 23 ~~on the coating fluid is shown, e.g., in Fig. 3~~
~~in storage tank 5.3.~~

[0099] A temperature setting device, ~~e.g. first temperature setting~~
~~device 25, acts indirectly on the~~ (such as the first temperature setting device
25) can indirectly heat or cool the coating fluid by, e.g., heating or cooling a tube between the
precision pump 4 and ~~atomising unit 1.~~ the exemplary atomizing arrangement 1. By
varying the temperature of the tube, the temperature of the coating fluid flowing through the tube
~~is~~ can be influenced indirectly.

[00100] ~~Besides the influencing the temperature of the coating~~
~~fluid by first temperature setting devices 23 and 25, the~~ The
temperature of the inert gas in an inert gas feed line 31 can be set by ~~means of~~ using the
second temperature setting device 24. ~~Since the~~ The tempered inert gas ~~interacts~~ can
interact with the spray mist ~~while~~ when it is escaping from the inert gas nozzle 33, and
~~modulates~~ may modulate the spray pattern of the spray mist, ~~the~~ The temperature of the
spray mist which has separated from the resonance body can also be ~~adapted~~ influenced by this
interaction between the spray and the inert gas which may be provided at a desired temperature
as described above.

[00101] The temperature prevailing in the coating chamber 32 can also ~~has~~ an
influence ~~on the dispersion behaviour~~ behavior and coating ~~behaviour~~ behavior of the
spray mist on the substrate. 14. This prevailing temperature ~~may~~ can also determine or influence
the ~~behaviour~~ behavior of the coating when it is being dried. ~~Moreover, the~~ The

WO 2005/065843

PATENT APPLICATION

thickness of the coating, particularly the coating film, on the substrate 14, can also be influenced by the temperature prevailing in the coating chamber 32.

[00102] Fig. 3 also shows a ~~device 29 for an~~ electrical apparatus 29 that is capable of generating an electrical field. ~~This has~~ The electrical apparatus 29 includes two electrodes which are can be connected to a high voltage generator 28 (HV). ~~Between the electrodes an~~ 28. An electrical field can be generated between the electrodes in the region between ~~atomising unit~~ the exemplary atomizing arrangement 1 and the substrate holder 9 and the substrate when 14 by application of a suitable voltage ~~is applied~~. In this case the substrate and, if applicable, also at least part of, The substrate 14 and, optionally, at least a portion of the substrate holder 9, may lie fully ~~in~~ within the electrical field, so that the field ~~act~~ can act on the spray mist when the sprayed particles adhere to the substrate 14.

[00103] ~~Whilst the figure~~ Fig. 3 also shows a single-channel structure of the device for generating an electrical field, ~~a~~ apparatus 29 that can be configured to generate an electrical field. A multi-channel structure ~~is also possible.~~ In the case of a multi channel structure can also be used, where a plurality of devices apparati 29 are may be provided for generating an electrical field, each of which ~~is~~ can be separately activated by HV the high-voltage generator 28.

[00104] HV The high-voltage generator 28 ~~has a connection to~~ can be connected to the microprocessor 7 ~~by which it can~~ and may be controlled by the

WO 2005/065843

PATENT APPLICATION

~~microprocessor. In addition to thereby. The high-voltage generator 28 can be configured to provide, e.g., electrostatic fields, or time-variable varying electrical fields, with which may have an intensity variable over that varies with time or different frequency patterns, can therefore also be realised.~~

[00105] Similarly to the electrical field, ~~a~~ A magnetic field can also be generated with device 30 for generating a magnetic field, for example, between ~~atomising~~ the atomizing device 1 and the substrate holder 9, ~~with substrate. This~~ 9 using a magnetic field apparatus 30. Such magnetic field apparatus 30 may be magnetostatic, i.e.g., it can be constant or time variant, i.e. variable over time. The modulation is carried out here by the LF/HF generator, which is with time or it may vary with time. The modulation of the magnetic field can be produced using a low frequency/high frequency (LF/HF) generator, which can be connected to the microprocessor, from 7 and which the LF/H generator receives can be configured to receive control signals, therefrom. A single-channel structure is also shown for the magnetic field, although apparatus 30 is shown in Fig. 3, and a multi-channel structure is possible. apparatus may also be used.

[00106] The magnetic field can be generated by ~~means of~~ using, e.g., a permanent magnet or an electromagnet. The magnetic field apparatus 30 shown in Fig. 3 shows includes an electromagnet. A U-shaped core such as, e.g., a ferrite core, is can be surrounded by an electrical coil on the an underside of the magnet, which is where the underside may be the side opposite the resonance body 2. Excited by the Magnetic field lines can be formed

WO 2005/065843

PATENT APPLICATION

~~between parallel flanges of the core when excited by a current flow generated by the LF/HF generator in the coil, magnetic. Magnetic field lines are formed between the parallel flanges of the core, which field lines can pass through the space between the flanges with a magnetic field. The space region between atomising unit the atomizing arrangement 1 and the substrate, and if necessary at least parts of 14, and optionally a portion of the substrate holder 9, is therefore can also passed through with a be exposed to the magnetic field. This magnetic field influences. The magnetic field thus may influence the spray mist to be moved on to being directed toward the substrate. 14.~~

[001071] Both device 29 for generating an the electrical field and device 30 for generating a apparatus 29 and the magnetic field, at least parts apparatus 30, or a portion thereof, may be located either inside housing 11, i.e. ing., within the coating chamber 3232, or outside of it. If a suitable material is selected for the housing 11, the electrical and magnetic fields may exert their actions in within the housing 11, i.e.g., from outside into the coating chamber 32. If device 29 for generating an electrical field, as well as device 30 for generating a Locating the electric field apparatus 29 and/or the magnetic field, are located fully outside housing 11, this may be advantageous in terms of contamination of these elements. apparatus 30 completely outside of the housing 11 may help to prevent or reduce contamination of these components.

WO 2005/065843

PATENT APPLICATION

[00108] The foregoing merely illustrates the principles of the invention. Various modifications and alterations to the described embodiments will be apparent to those skilled in the art in view of the teachings herein. It will thus be appreciated that those skilled in the art will be able to devise numerous systems, arrangements and methods which, although not explicitly shown or described herein, embody the principles of the invention and are thus within the spirit and scope of the present invention. In addition, to the extent that the prior art knowledge has not been explicitly incorporated by reference herein above, it is explicitly being incorporated herein in its entirety. All patents, patent applications and publications referenced herein above are incorporated herein by reference in their entireties.

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